**I. Force and Inertia:**

**1. Force:**

**a) Fists and fingers**- One person holds their fists together tightly. A second person will use their two index fingers to strike the fists sideways and separate the fists.

Reason- Forces up and down (vertical) are defenseless against forces pushing side ways (horizontal). The only help you get to keep your fists together is a small friction force.

**b) Dollar drop or reflex tester-** The catcher rests his wrist on the table to keep from following. The dropper holds the dollar vertically at the top. The catcher positions fingers on either side of George Washington's face, as close as he or she wants without touching the bill. When the bill is released, try to catch it with fingers. Impossible!

Why? The gravitational force on the dollar causes it to speed up instantly, outrunning the person's reflexes.

**2. Energy & Momentum:**

|  |  |
| --- | --- |
| Photo of Demo | |
| **Description:** | A tennis ball is held in contact with a basket ball, then the two are dropped as one. The basketball has a higher momentum since is has a higher mass. When they hit, the mometums "switches"; i.e. the tennis ball has a momentum equal to that had by the basketball before the collision. The effect is a very fast moving, high bouncing tennis ball. | |

**3. Inertia:**

**a) Card and quarter**- Place a quarter on a card, and the card on a middle finger being careful to place the quarter directly above the finger. With the other hand, try to flick the card out from under the quarter. An easier trick would be to place a card on top of a glass. Place any object on top of the card. Flick card and the object will fall into the glass.

Why it works- Objects have inertia and resist motion unless a force is applied. The force down caused by gravity is much greater than the small friction force pushing the object side ways.

**b) Marbles and rice**- Place a marble in the bottom of a jar and fill the jar with rice. Rest a glass on one hand and apply sharp downward taps to the top rim of the glass with the other hand. The marble will rise to the top.

Why it works- Inertia of the marble is greater than the individual grains of rice. The tap delivers enough force to cause the rice to fall, but not the marble. So actually, it doesn't move, the rice falls out from underneath it.

Materials  
two fists  
two fingers  
dollar  
dropper  
catcher  
card  
quarter  
finger (or glass)  
string  
body  
two experimenters  
marbles  
rice  
cup  
paper rectangles barely attached  
paperclips  
fifty cards  
small weight

Why? Because the force applied by the sheet to the egg is the change in the momentum of the egg divided by the time interval required to bring the egg to a halt. Since the egg stops much slower when thrown against a sheet than it does when thrown against a brick wall, the force is much smaller. Usually it is not enough to break the egg.

**II. Atmospheric Pressure and Bernoulli's Principle:**

**1. Straw in glass of water**- Level of fluid is same as level in glass.

Reason- Atmospheric pressure is inside the open straw as well as the glass.

**Force vs. Pressure**  
  
**2a.** Place finger over top of straw, shielding the top from the atmosphere. What happens if you pick up the straw?

Why? Atmospheric pressure pushing up from the bottom opening is more than gravity pulling down on the water, since there is very little pressure down from the top.  
  
**2b.** Fill glass with water and place a piece of paper on top. Ask what will happen when the glass is turned upside down. The water stays inside!

Why? Same reason water stayed in the straw with your finger over it (along with some surface tension).

**3a.** how do you lower pressure? Bernoulli's Principle  
Place one straw in water. Using a second straw, blow across the top of the straw in the water. What happens?

Why does water come out of the top? Increased velocity of air above the straw LOWERS the pressure there. Water is pushed up from the bottom by atmospheric pressure pushing down on the surrounding water in the glass.

**3b.** Will this work if you blow across the bottom of a straw full of water held up with a finger on top? Try it.  
  
**4. The Paper House:**  
Build the paper houses ahead of time. Blow through them and see how they hug the table. Then cover one end with the ruler and blow across the top (maybe using the straw) and see what happens. Ask them to explain this. Answer- When you blow through the house, low pressure is created inside, and atmospheric pressure pushes down from the top. When you blow across the top, low pressure is created just above the house and atmospheric pressure inside the house pushes it up!

Materials  
three glasses  
three tubs  
lots of straws  
many paper houses  
three rulers  
puff balls  
beach ball  
leaf blower

**III. Electricity & Magnetism:**

**Electric Motor:**

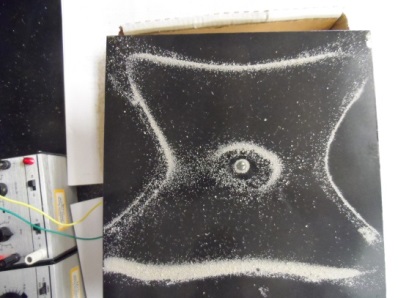
[](http://www.google.com/imgres?imgurl=http://www.hbquik.com/dparka/motor/motorspinani.gif&imgrefurl=http://www.mymotor.org/&h=480&w=640&tbnid=kZZLpyduij12YM:&zoom=1&q=simple+electric+motor&docid=12mLIphNJp3jmM&ei=D9LUVPf5OIzWgwScpYLoCQ&tbm=isch&ved=0CFsQMygeMB4)

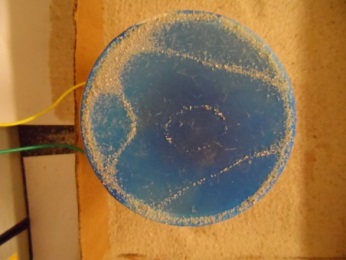
<http://www.mymotor.org/>

**IV. Chladni Plates**

Different shaped plates, such as a polygon, square or circle, will vibrate only at certain frequencies. These are called "modes" and each mode is characterised by a set of lines called "nodal lines". These are lines where there is no movement.

Demonstrating of one of Chladni patterns using 12”X12”square with low cost equipment.

